

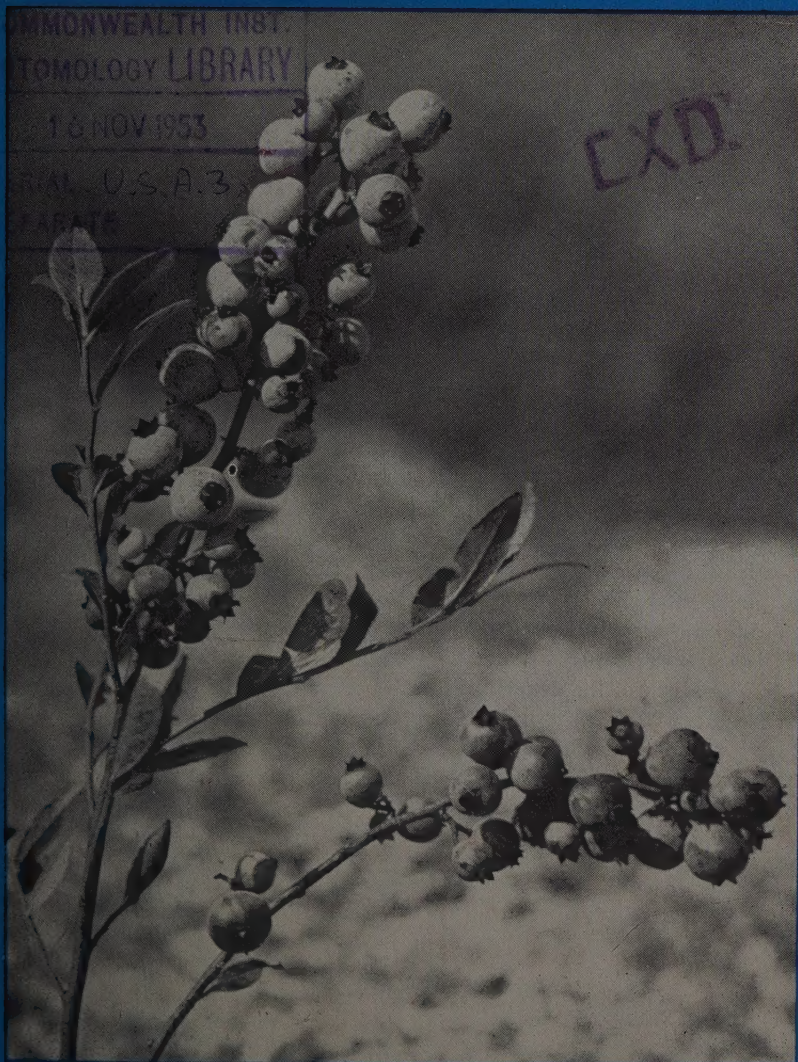
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Producing Blueberries in Maine

Bulletin 479

March, 1950

The Maine Agricultural Experiment Station
Orono, Maine

To Blueberry Growers:

This report has been prepared to give you the most up-to-date information and recommendations for blueberry production under Maine conditions. The information has been summarized by our team of experts conducting blueberry research.

The report suggests the best procedures in the use of fertilizer, dust for controlling insects and diseases, products for killing weeds and bushes, and honeybees for obtaining a better set of fruit.

Although the answers are given for a number of blueberry problems, much more research is needed. The Maine Agricultural Experiment Station plans to continue intensive study of blueberry problems at Blueberry Hill Farm and in cooperation with blueberry growers in various parts of the State.

Much of the detailed research upon which this report is based has been made possible by blueberry tax funds.

We hope that this handbook will be helpful to you. If you have any questions or suggestions, we shall be glad to have you write us.

Sincerely yours,

George F. Dow

George F. Dow
Assistant Director

Orono, Maine

CALENDAR OF BLUEBERRY WORK

September

Mow weeds and bushes late in September; then haul and pile hay onto the land to be burned over next spring.

October and November

Spread hay on land to be burned over next spring, or burn over land to be burned with oil this fall.

December and January

Repair old equipment, and build any needed new equipment.

February, March, and April

Burn over land as soon as conditions permit.

April and May

Transplant blueberry plants as soon as frost is out.

Apply fertilizer just as the plants begin to grow.

Keep watch of blueberry plants for signs of cutworm injury and apply treatment if necessary.

May

Keep watch for flea beetle injury to the developing blossom buds and apply treatment if necessary.

Apply treatment for thrips control on places where infestation was severe last year.

May and June

Place honeybees on your land just as the blueberries have started to bloom. Remove the bees before dusting begins.

Apply treatment for disease control as soon as 95 per cent of the blueberry blossoms have dropped.

July

Apply treatment for weed control.

Apply treatments for fruit fly control when announced by your county agent.

Harvest available hay for use in burning.

August

Harvest and market the blueberry crop.

Continue treatments for weed control.

Harvest any additional hay that is needed for burning.

See table of contents on the next page to locate each section for more detailed information.

CONTENTS

	PAGE
Importance of Blueberry Crop.....	5
Species or Varieties of Blueberries.....	7
Blueberry Soils.....	8
Burning Over Blueberry Land.....	10
Use of Fertilizer.....	12
Goal in fertilizer practice.....	12
Kind of fertilizer to apply.....	13
Amount of fertilizer to apply.....	14
When to apply fertilizer.....	14
Application of fertilizer.....	15
Increasing the Stand of Blueberry Plants.....	15
Use of cuttings.....	16
Transplanting blueberry sods.....	17
Cultural methods.....	17
Honeybees and Blueberry Pollination.....	18
Frost Damage.....	20
Blueberry Insects and Their Control.....	20
Blueberry fruit fly.....	20
Black army cutworm.....	22
Measuring worms.....	24
Blueberry flea beetle.....	24
Blueberry leaf roller.....	25
Blueberry thrips.....	26
Blueberry Diseases and Their Control.....	27
Leaf rust.....	27
Powdery mildew.....	28
Witches'-broom.....	28
Red leaf disease.....	29
Mummy berry.....	30
Brown leaf spot.....	30
Twig blight.....	30
Control of blueberry diseases.....	30
Weed Control.....	32
2,4-D.....	32
Ammate.....	34
2,4,5-T.....	34
Application of herbicides.....	34
Precautions in use of herbicides.....	34
Crop Protection from Birds and Animals.....	35
Deer.....	35
Smaller animals.....	35
Herring gulls.....	35
Harvesting Blueberries.....	36
Marketing the Crop.....	40

PRODUCING BLUEBERRIES IN MAINE

IMPORTANCE OF BLUEBERRY CROP

G. F. Dow

The volume of blueberries purchased by Maine processors during recent years has amounted to about 200 to 400 thousand bushels annually. The amount paid for blueberries is over one million dollars a year, and amounted to about two million dollars in 1943, 1946, and 1948. This production, which is concentrated primarily in a narrow strip along the coast, makes Maine the leading blueberry state in the Nation.

According to the 1940 census, Maine had 83 per cent of the total blueberry acreage harvested in New England during 1939, about three-fourths of all the native wild blueberries harvested in the United States, and about two-thirds of the total acreage of all wild and cultivated blueberries in the United States.¹ The 1950 census may show substantial increases in production in several areas. The 1940 census, however, reported the volume harvested in Maine to be about eight times larger than in either New Jersey or Michigan which ranked second and third in importance. New Jersey blueberries consist primarily of the high bush, cultivated, named varieties, but the Michigan berries are mostly native wild berries as in Maine.

The volume of blueberries purchased by Maine processors during

ANNUAL VOLUME, PRICE, AND AMOUNT PAID
FOR BLUEBERRIES BY MAINE PROCESSORS²

Year or period	Average no. bushels purchased annually	Average price paid per bushel	Average amount paid annually
1924-27	166,098	\$3.30	\$ 548,338
1928-32	208,112	2.20	457,389
1933-37	196,367	2.20	431,457
1938-42	254,016	2.53	641,644
1943-47	254,413	6.29	1,600,378
1948	422,629	4.68	1,979,172

¹ General Report, Agriculture Vol. III, Statistics by Subjects. 1940 Census, Bur. of Census, U. S. Dept. Commerce, p. 838.

² Information summarized from annual reports of Blueberry Pack, Div. of Markets, Maine Dept. of Agr.

the past 25 years has shown a continued upward trend. Purchases during 1924-27 averaged 166,098 bushels annually as compared with 202,240 in 1928-37, and 254,215 during 1938-47. Purchases in 1948 were at an all-time high of 422,629 bushels, due in part to importations from Canada.

Blueberry production in Maine is expected to increase as new areas and new fields come into bearing, accompanied by an increase in plant stands in many existing fields. Another important factor is the increased interest on the part of growers in using the results of research in applying 2,4-D and other substances to control weeds, to follow the recommended dust schedule in controlling insects and diseases, to improve pollination by providing bees, and to increase yields by the use of fertilizer.

The yield of blueberries per acre varies greatly from field to field due to the number of plants per acre, and other factors. The census reported that the 1939 crop in Maine averaged only about nine bushels per acre. A survey in Maine, based on the years 1924-26, showed an average of about 13 bushels annually per acre.³

For 70 growers included in a 1949 survey, the average yield was 23 bushels per acre for first crop yields, 8 bushels for the few growers who had second crop yields, and no yield during the year of burning. Many fields, of course, bear larger than average yields.

Total production in Maine has varied considerably from year to year due to the effects of early frosts, drought during the growing season, winter injury, insects and diseases. The smallest crop during the past 25 years was in 1944 when the army cutworm and other adverse factors cut production to only 83,410 bushels, or about one-third of normal.

The average price received by growers has varied widely due to changes in the general level of all prices, and changes in the supply and demand for blueberries. From 1924-29 the price paid Maine producers averaged \$3.32 per bushel. During the depression period from 1931-35 the price averaged \$1.48 per bushel; recovered to \$2.55 for 1936-37; dropped back to \$1.38 for 1938-39; and then increased during the war period to a peak of \$8.12 in 1946. The 1947-49 prices were about \$4.67 per bushel.

The more important blueberry counties are along the Maine coast. The Experiment Station mailing list of blueberry producers now includes 870 growers in Washington county, 604 in Hancock county, 417

³ Merchant, Charles H. An Economic Study of 239 Blueberry Farms in Washington and Hancock Counties, Maine. Maine Agr. Exp. Sta. Bul. 351, p. 71. 1929.

in Knox and Lincoln counties, and 131 in Waldo county. The remaining counties have relatively few commercial producers, but interest appears to be growing in Oxford county with 57 now on the mailing list, and in Cumberland county with a total of 29 producers. As a result of the big forest fires in York county during the fall of 1947, this county may become a more important source of blueberries.

SPECIES OR VARIETIES OF BLUEBERRIES

M. T. HILBORN

There are two general kinds of blueberries growing in Maine. The wild low-bush blueberry is the kind most widely distributed and includes most of the commercial crop. It is of major importance in the coastal area of the eastern section of the State.

The high-bush blueberry is of some commercial importance in small local areas, most of which are in southwestern Maine. The cultivated named varieties have not been grown to any extent in the State, due in part to winter injury.

The several species of wild low-bush blueberries hybridize freely and, since blueberries spread as "clones" in a field by means of underground shoots, many different kinds may be found growing together. A rather complete technical discussion of about 20 different species of blueberries growing in Maine has been published.⁴ It is extremely difficult, however, for the average grower to identify these different species.

For the purpose of this discussion the wild low-bush blueberries will be divided into two general groups. These are the low sweet blueberry (*Vaccinium angustifolium* Ait. and its close relatives), and the sour-top blueberry (*Vaccinium canadense* Kalm. and its close relatives).

The low sweet blueberry is the most widespread, and commercially the most important in Maine. The plants vary from 4 to 15 inches in height and the leaves are shiny on both sides. The berries vary in shape usually being somewhat flattened at the ends. They range from about $\frac{1}{5}$ to $\frac{5}{8}$ inch in diameter. The ripe berries usually are blue in color but on some of the closely related varieties included in this general group are sometimes black, and occasionally are white, pink, or red. The blue-colored varieties are considered most desirable for the fresh fruit market.

⁴ Hyland, Fay, and F. H. Steinmetz. The Woody Plants of Maine. University of Maine Studies, Second Series No. 59. 1944.

The sour-top blueberry grows with the low sweet blueberry, but in older fields seldom occupies a large area. In general, it seems that the sour-top blueberry is not spreading as much as the low sweet and this has been attributed to the burning of fields by growers. Apparently the burning practice often injures the sour-top blueberry but increases the spread of the low sweet blueberry. The sour-top plants range from 8 to 20 inches in height, with numerous hairy branches near the clusters of berries. The leaves are downy on both sides. The berry is about the same size as the low sweet blueberry but is somewhat elongated in shape. The berries are of varying shades of blue and have a slightly tart flavor.

The high-bush blueberry (*Vaccinium corymbosum* L.) occurs locally in small areas in the southern half of Maine, but is of economic importance only in the southwestern part of the State.

The low-bush and high-bush blueberry sometimes hybridize resulting in the so-called "half-high" plants (*Vaccinium angustifolium* x *corymbosum*). These plants are found throughout the areas where both parents occur naturally, but are of little economic importance.

BLUEBERRY SOILS

M. F. TREVETT

The commercial acreages of low-bush blueberries are found mostly on well-drained sandy loam or loamy sand soils. In the forest, these soils are covered with a mat of organic litter (leaves, needles, and twigs) that may range from one to four inches in depth. The depth of the litter in blueberry fields, of course, depends upon the age of the field and the number of deep, hard burns that the land has received. Light burns, made when the soil is either frozen or wet, apparently do not greatly reduce the depth of the surface layer of organic matter. A relatively deep layer of organic matter in an old blueberry field is shown in the picture on the next page.

Most blueberry soils are not fertile soils. Of 215 soil samples taken in Washington County, 97 per cent were low or very low in available phosphorus, 72 per cent were low or very low in available potassium, and 80 per cent were low or very low in available calcium and potassium. The average pH for 215 soil samples was 4.7.

Thus far no relationship has been found between the mineral content of the soil and the yield of blueberries. Consequently, at the present time, soil tests are of no value in making fertilizer recommendations. Preliminary studies indicate, however, that the deeper the organic mat, the greater the height of the blueberry plant.



Remaining organic matter
from forest litter

Light gray or nearly white
structureless loamy sand
(in plowed soils this
layer will be mixed with
the layer above)

Brown sandy loam;
somewhat cemented
in places

Yellowish brown loose
material, either sand
or gravel

Gray sand or gravel

Profile of a Typical Soil Taken From an Unplowed Blueberry
Field: Colton Sandy Loam. Photograph by Fred Chandler.

BURNING OVER BLUEBERRY LAND

I. C. MASON

Most blueberry growers burn their fields every two or three years. This is the only practical method that has been found to date for pruning the low-bush blueberry. Periodic burning also aids in controlling certain insects and diseases. On the other hand, burning has some disadvantages in that it prevents an increase of organic matter in the soil and results in the loss of all the nitrogen in the burned plants. The fire hazard in burning also is a serious menace to adjoining fields and woodland.

To obtain a good burn, some kind of fuel usually must be spread on the field. Most growers use hay, but straw, shingle hair, planer shavings, or fuel oil may be used. Salt marsh hay or other substitutes may be preferred to regular hay (locally known as English hay) because they do not contain weed seeds such as goldenrod, hawkweed, or clover. About one ton of hay is required per acre to obtain a satisfactory burn. The quantity may be reduced if considerable amounts of grass and weed bushes are growing in the field. Native grasses help to give a better burn, but make the raking of the blueberry crop more difficult. If not enough hay is used, old, partly burned stubs will be left which interfere with raking and crush the berries.

The hay, or similar material, usually is distributed in the field in small piles, and is then spread carefully by hand during the fall. The hay should not be spread prior to late September or October, until the blueberry leaves have turned red or have fallen. Some growers mow the weeds and bushes in September just prior to spreading the hay. This practice helps to obtain a better burn and makes it easier to spread the hay. One man will spread about a ton of hay a day, or the average.

Burning usually is done in the early spring, in March or April. The best time to burn is the first dry period after the snow has gone and before the frost is out of the ground. An early burn is important for several reasons. An early burn provides a longer growing season for developing new growth and fruit buds for the next crop. It is important that the ground should be frozen or thoroughly wet at time of burning in order to protect the top soil, as well as the crowns and roots of the blueberries.

Blueberry land may be ruined for many years by a late deep burn which destroys the organic matter. Much of the so-called "blueberry barrens" is land that has been carelessly burned and cropped for 100 years or more, resulting in a depletion of the organic litter and a poor stand of plants. On large tracts of such barren land it is not economical

to spread hay, so the area is burned over only once in four or five years. The land is allowed to lie idle until enough growth and material has accumulated to permit an adequate burn.

The fire hazard to adjoining woodlots is considerably reduced if fields are burned early in the spring. Occasional skips due to wet spots may occur in early burning. They can be cleaned up with a small hand oil burner or by the addition of more hay. To reduce the fire hazard to a minimum, neighbors usually exchange work in burning, or several men are employed who are equipped with brooms, shovels, Indian fire pumps and other fire fighting equipment. A back swath also is usually burned before starting the fire on a large scale. Many growers use an oil pipe with a burning wick for starting the fires. This is dragged across the field by hand, and may be more efficient than using matches.

A relatively new method of burning, that has been used successfully during the past few years, has been the use of the "Woolery Weed Burner." This burner uses fuel oil to produce a hot flame for burning the bushes, so that no hay is needed. The oil burner can be used late in the fall as well as in the spring. This burner has proven to be economical on some fields that were not too rough or stony. A few precautions, however, should be followed. Oil, if spilled or sprayed on



A Commercial Oil Burner Used in Burning Over
Blueberry Land.

unburned bushes, will kill the bushes. The oil must be burning when it reaches the stems of the blueberry plants. The speed of the burner must be regulated so that the fire does not burn too deeply and injure the plant crowns.

Some growers burn their fields every other year; others burn once in three years. Which practice is most profitable depends largely upon the yield of the second crop as compared with the first crop. In relatively new blueberry fields, the two-year burn may be preferred because it may help to increase the stand of plants. Each time the bushes are burned, new shoots grow out from the old plant and underground rhizomes may spread out and develop new shoots beyond the old plant. The two-year burn, however, requires more frequent use of hay, which is a large item of cost. With a two-year burn, only one crop is harvested per burn, whereas with a three-year burn, two crops are harvested. A three-year burn allows more grass, weeds, and bushes to develop which gives a better burn. The second crop of berries, however, is usually considerably less than that of the first crop.

Additional information is needed as to the relative advantages and disadvantages of the two-year versus the three-year burn. The use of fertilizer and other new practices also may influence future recommendations.

USE OF FERTILIZER

Tests made by the Experiment Station show that commercial fertilizers may increase yields of blueberries. Sometimes, however, higher yields have not been obtained, and occasionally yields have been decreased. More research is needed before one can predict accurately the benefits from fertilization under different conditions.

Goal in Fertilizer Practice

Tall stems ordinarily produce more fruit buds than short stems. Consequently the objective of the grower during the year of the burn is to produce a tall stem early in the season so as to insure abundant fruit bud formation for the first crop. The objective during the year after burning is to produce numerous side branches, without decreasing the production of the first crop. These side branches are essential for obtaining a high yielding second crop if a three-year cycle is followed.

Although fertilizers may improve crop yields, they should be used with caution. Too great a growth during the year of burn will result in tall, slender stems with fewer fruit buds than are found on unfertilized plants. Evidently, fertilizers must be applied at rates that will not upset



Farmhouse and Laboratory at Blueberry Hill Farm, Jonesboro, Where About 30 Acres of Blueberry Land is Used for Fertilizer Experiments and Other Research Studies on Blueberries.

the delicate balance that exists between vegetative growth and fruitfulness.

Unfortunately, the use of fertilizer for blueberries also causes a luxuriant growth of weeds that may crowd out blueberry plants. Consequently it may be undesirable to fertilize fields that abound in grasses or low growing weeds. Even in comparatively weed-free fields the amount of fertilizer applied will be a compromise between what the blueberries actually need, and the amount that will cause the least growth of weeds.

In spite of these dangers and difficulties, there is a need for a fertilizer program, especially on long established fields where yields have been slowly decreasing. The problem is to control growth so as to obtain vigorous blueberry plants with maximum yields for both the first and second crops.

The selection of a fertilizer program requires consideration of (1) the kind of fertilizer that will contain the plant foods the soil does not adequately supply, (2) the rate of application that will not over stimulate blueberry plants or weeds, and (3) the time of application so that these foods can be used most effectively to produce higher total yields.

Kind of Fertilizer to Apply

For most crops, complete fertilizers are used to insure good growth. In blueberry fields, however, complete fertilizers such as a 7-7-7 (which contains nitrogen, phosphorus, and potassium) have not *consistently* been better than fertilizers containing only nitrogen. Nitrogen, either alone

or with the other nutrients, invariably has caused striking and immediate growth. The use of phosphorus and potassium have not generally shown any improvement as compared to unfertilized plants. On the basis of present evidence, it appears that the most profitable practice is to apply fertilizers that contain only nitrogen.

Amount of Fertilizer to Apply⁵

With present methods, soil tests are of no value in indicating the amount of nitrogen needed. The amount to apply must be based on the vigor of the plants, and on the abundance and kinds of weeds found in the field. Moderately weedy fields usually can be fertilized at low rates without excessive growth of the weeds present. Fertilizer trials, however, are needed in each field to determine the effect on weed growth, and whether it will be desirable to continue to fertilize.

If the vigor of blueberry plants is used as a guide, it appears that relatively large applications of nitrogen will be required on fields in which the majority of the stems are less than four inches tall. On the other hand, if the majority of the stems are more than six inches tall, relatively small applications of nitrogen probably will suffice.

The following rates are suggested for trial applications of fertilizer on land that is relatively free of grass. It is assumed that only one application of fertilizer will be made in the period between burns.

If the majority of the stems of the blueberry plants have been less than four inches in length, apply on a per acre basis one of the following: 450 pounds of 7-7-7, 600 pounds of 5-10-10, 100 pounds of ammonium nitrate, 200 pounds of nitrate of soda, or 160 pounds of ammonium sulphate.

If the majority of the stems of the blueberry plants have been more than six inches in length the per acre application should be about 250 pounds of 7-7-7, 350 pounds of 5-10-10, 50 pounds of ammonium nitrate, 100 pounds of nitrate of soda, or 80 pounds of ammonium sulphate.

When to Apply Fertilizer

Fertilizer should be applied early in the spring about one week to ten days before growth begins.

Only one application is made in the period from burn to burn.

The results obtained from the use of fertilizer depend upon the year when the fertilizer is applied. In a three-year period between

⁵ A more detailed discussion of experimental results and the basis upon which recommendations are made have been included in a mimeographed report, "Use of Fertilizer for Maine Blueberries," a copy of which may be obtained by writing to M. F. Trevett, Plant Science Building, Orono, Maine.

burns, fertilizer that is applied either the year before the burn or the year of the burn usually causes an appreciable increase in yield for only the first crop. Fertilizer applied during the spring of the first crop year tends to decrease slightly the yield of the first crop but more than doubles the yield of the second crop, resulting in a higher total yield for the first and second crops combined.

If the land is burned every other year, instead of every three years, the fertilizer should be applied in the spring of the year of the burn.

Application of Fertilizer

Fertilizer should be distributed uniformly. Uneven distribution will result in too much fertilizer on one part of the field, and too little on another part.

Because of the difficulty of accurately estimating the amount being applied, uneven distribution is likely to occur when fertilizer is broadcast by hand. Accurate hand broadcasting will be made easier if the field is considered as being divided into many small areas; for example, strips 10 feet wide and 100 feet long. The amount of fertilizer that must be scattered over a strip 10 x 100 feet long, for various acre rates, is as follows:

POUNDS PER STRIP to equal	POUNDS PER ACRE
1.2	50
2.3	100
4.6	200
6.9	300
9.2	400
11.5	500
13.8	600

Because of the difficulty in uniform broadcasting of small amounts of fertilizer by hand, it is suggested that the fertilizer be mixed with about double the volume of sand before applying.

INCREASING STAND OF BLUEBERRY PLANTS

F. P. EGGERT

One of the more important factors affecting the yield per acre of low-bush blueberries is the stand of plants. On small areas in a good field, yields on an acre basis may be very high but because of the lack of plants on adjacent areas the average yield for the entire field is low.

Methods are needed for filling in the areas in blueberry fields which at present lack plants. If the stand of plants on many fields could be increased, the yields and profits per acre could be increased also.

Use of Cuttings

Studies conducted at Blueberry Hill Farm and in the Station Greenhouse show that the low-bush blueberry can be easily propagated by using cuttings of the "rhizomes" which are the underground stems of the blueberry plant.⁶ Since these rhizomes are stems rather than



A Two Year Old Blueberry Plant Grown from a Rhizome Cutting.
Note the vigorous growth of uprights and roots. The white growths are rhizomes which spread out to form new plants.

roots, they are similar to the above ground portion of the plant, and have what is known as "polarity." That is, the tip end of any cutting tends to produce upright growth, whereas the basal end, nearer to the original plant, tends to produce roots. Because of this, care should be used in planting these cuttings for rooting. This is especially true if the cuttings are to be treated with hormones to increase rooting. Experiments show that there is a very marked increase in the amount of rooting if the basal ends of these cuttings are dipped in hormone preparations. In contrast, if the tip end is treated, growth is greatly reduced, especially upright growth, and many cuttings will not survive.

⁶ Hitz, C. W. Increasing Plant Stand in Blueberry Fields. Maine Agr. Exp. Sta. Bul. 467. Feb. 1949.

In general, the longer the cutting the greater will be its chance for survival. A six-inch cutting has about twice the chance for survival as does a three-inch cutting. There is very little difference in the amount of rooting for cuttings with a small diameter and those with a large diameter.

Most of the experimental work with blueberry cuttings has been done in the greenhouse. Additional testing is needed to determine the survival and growth of these cuttings in a nursery, or in blueberry sod. Several plots have been laid out to determine the possibilities of planting unrooted cuttings directly into prepared soil. Preliminary observations indicate that this may be a valuable method of establishing a blueberry sod where the stand of plants is very light.

Transplanting Blueberry Sods

Another means of spreading blueberry plants is to transplant blueberry sods in barren areas. A golf-hole cutter can be used to obtain the blueberry sods and to make the holes in the barren areas in which these sods are placed.

In either of the above methods, clones, or clumps of bushes should be chosen which are bearing the most desirable blueberries.

Cultural Methods

In many places, the stand of plants is thick enough to make a field worth harvesting but not thick enough to return a high profit. If by some cultural treatment the stand of plants could be increased, a larger profit might result.

Experiments with a turf hoe show that if the blueberry rhizomes (underground stems) are cut in the sod, new growth will occur where the cut was made. At least 50 per cent of the severed rhizomes may be expected to show new upright growth and increased rooting under these conditions. It may be practical to use a turf hoe for this purpose in small fields where plant stand needs to be increased. Further research is planned to determine how far apart the cuts should be made to bring about the most rapid increase in plant stand.

For large commercial fields, special equipment is being developed for cutting the blueberry sods without doing too much damage to existing plants. A disc harrow has been used in preliminary trials but the curved blades uprooted and damaged too many plants. The number of new plants resulting from the cut rhizomes was not sufficient to replace the plants destroyed.

HONEYBEES AND BLUEBERRY POLLINATION

F. H. LATHROP

Blueberry blossoms are dependent upon insects for pollination. Many kinds of insects help to pollinate the blossoms. Among them are several species of bumblebees, a number of kinds of "solitary" wild bees, numerous flies and beetles, and, of course, honeybees. The number of bumblebees, "solitary" bees, and other insects observed on blueberry blossoms varies greatly from season to season. Such insects are subject to the influence of climatic conditions. Under favorable conditions, they are abundant, but when conditions become unfavorable they are scarce. Many pollinating insects have been killed where dust was applied when the blueberry plants were in bloom, or where dust was applied when plants other than blueberries were in bloom on blueberry land. In applying dust for pest control, blueberry growers should be careful to avoid killing the pollinating insects.

Because there seems to be an increasing scarcity of native pollinating insects on some good blueberry land, many blueberry growers have become interested in using honeybees. Observations on land where hives of honeybees have been placed, show that in many areas there appeared to be a considerable increase in the yield of blueberries as a result of the activities of the honeybees. In some other places where honeybees were used, little increase in yield was apparent. The use of honeybees may be especially valuable when weather conditions are unfavorable for pollination. Under such unfavorable conditions it is important to have honeybees on the blueberry land to take advantage of every moment favorable for pollination.

The honeybees should be concentrated especially on areas where observations in past years have shown a scarcity of native bees. Bees can be of maximum benefit where there is an abundant bloom that has not been injured severely by frost or by pests.

The number of hives of bees that it is advisable to use on blueberry land varies greatly with conditions. If bees are used quite generally over a large area, the number of hives used in any place can be reduced. Where bees are placed on only a comparatively small piece of land surrounded by blueberry land on which no honeybees are placed, the number of hives per acre should be increased. As a working basis, it is generally considered that one strong colony of honeybees should be used per acre on small areas. Probably on large areas, one hive will cover more land.

For best results the honeybees should be placed on the land just as the blueberries have started to bloom. If practicable, the honeybees should be removed from the blueberry land promptly after bloom, before the blueberry land is dusted.



Blueberries in Blossom.

A combination of bees and good weather is necessary for pollination and a good set of fruit.

Research on honeybees and pollination is being continued at Blueberry Hill Farm, and reports will be made from time to time as additional information becomes available.

For some crops, the application of chemical hormones has induced fruit set without pollination. The hormones tested as Blueberry Hill Farm, however, did not cause any appreciable increase in the set of blueberries. Further work will be done on this phase of pollination.

FROST DAMAGE

F. P. EGGERT

In certain areas, the killing of blossoms and of young fruits by late spring frost may be one of the greatest sources of loss to the blueberry grower. In many cases, however, frosts are blamed for lack of fruiting when the fault is due entirely to inactivity of bees and other pollen-carrying insects. The best time to determine frost damage is during the bloom period, when frost damage will show in the flower itself. If the pistil and ovaries (female parts of the flower) are black when examined several hours after the low temperatures occur, one would generally conclude the damage was due to frost. If, however, these flower parts are green and healthy, any lack of fruit set must have been due to some other reason—possibly, poor pollination on the part of bees.

Frost damage usually is most severe in low areas or in pockets which have poor air drainage. As a general rule, such land should be used for some other crop. The use of smudge pots or fires for frost prevention is not adaptable to the blueberry areas because of the work and expense involved. If irrigation equipment is available, frost may be avoided by spraying the plants with water. The water should be applied throughout the period of low temperature.

BLUEBERRY INSECTS AND THEIR CONTROL

F. H. LATHROP

Most of the insects that attack blueberries in Maine can be controlled by the proper use of insecticide dust. Some of the points that require careful attention for the effective use of dust are:

1. Learn to recognize the kinds of insects and the injury that they cause.
2. Apply the right kind of dust mixture at the proper time for each pest that needs to be controlled.
3. Dust only when the air is calm. It is better to dust when the bushes are wet with dew, but sometimes it is satisfactory to dust in the evening when dew is about to form.
4. Do not dust when blueberries or other plants are in bloom on the blueberry land.

Blueberry Fruit Fly (Rhagoletis pomonella)

The fruit fly has been the most generally troublesome insect pest of blueberries in Maine. The fruit fly overwinters in a resting stage an inch or two under the surface of the blueberry soil. The flies begin to

emerge from the soil just as the very first blueberries ripen—in Washington County about July 1 and somewhat earlier in sections farther south and west. The flies begin laying eggs, just under the skin of the berries, when about 3 to 5 per cent of the blueberries are ripe. Egg laying is largely completed in about 30 days. The small light-colored larvae that hatch from the eggs feed and grow within the blueberries. Early in August, when most of the blueberries have ripened, the full grown larvae begin leaving the berries to enter the soil where they remain during the winter.

Control of the fruit fly by dusting has become a general practice in Maine. The most satisfactory dust mixture so far discovered consists of 50 per cent calcium arsenate, 10 per cent monohydrated copper sulphate, and 40 per cent hydrated lime. The calcium arsenate is the main killing agent. The monohydrated copper sulphate serves to reduce the burning of the blueberry plants and appears also to help kill the flies. The hydrated lime dilutes the mixture, helps to prevent injury to the plants, and reduces the cost.

It is the general practice to make two applications of the dust.



Fruit Fly Traps at Blueberry Hill Farm.

Infested berries are placed during late summer in large boxes over cloth funnels through which the larvae pass from the berries into the soil where they overwinter. Next summer the flies emerge from the soil and are caught in small cages like the one shown in the foreground. Growers are then notified that it is time to apply dust to control fruit flies.

Where infestation of the flies is severe, the dust should be applied at the rate of six pounds per acre at each application. On land where the infestation is light, growers have found that the dust can be decreased to four pounds per acre.

The first application of dust should be made within 10 days after the first flies begin to emerge, which is usually just as the berries begin to ripen. Observations are made on the emergence of fruit flies in traps at Blueberry Hill Farm in Jonesboro, and announcements as to the dates of application are sent to growers by the county agents. The second application should be made 7 to 10 days after the first rain following the first application. The second application should not be delayed longer than 15 days after the first fruit fly dust.

Some growers have secured satisfactory control of fruit fly by a single application of dust on land where the infestation has been reduced by several years of thorough dusting. If a single application is to be used, probably best results can be secured by applying it a little later than the first application usually is applied.

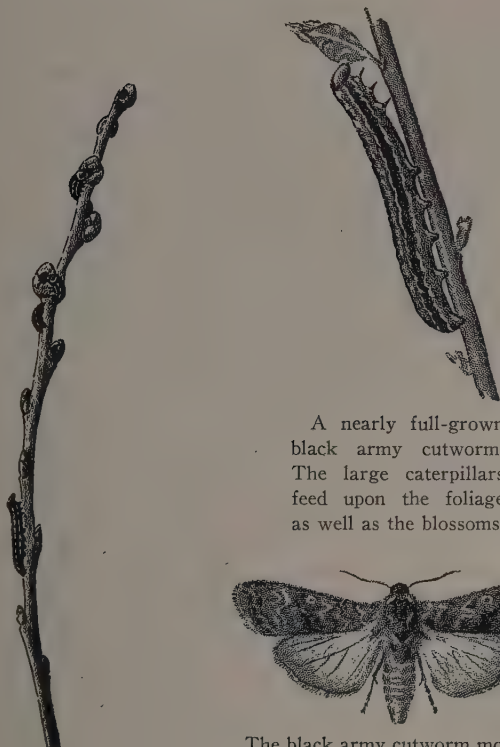
Black Army Cutworm (Actebia fennica)

There are a number of species of cutworms that are injurious to blueberries, but fortunately, widespread and destructive outbreaks of cutworms do not often occur. A great outbreak of the black army cutworm occurred in 1924 and 1925. Then the pest subsided and caused the blueberry growers no concern until 1944 and 1945, when the crop was destroyed on hundreds of acres of land through the coastal blueberry areas. Since 1945 no widespread outbreak has occurred, but there have been some locally destructive infestations. Although some cutworms have been found in many places since 1945, causing more or less injury to the blueberry crop each spring, the growers have generally overlooked this annual injury.

A very small amount of cutworm injury to the fruit buds usually can be found in the late fall. In general, however, the very small, young cutworms begin feeding in the early spring, just as soon as the snow goes off and the blueberry fruit buds begin to swell. In some seasons injury to the buds may occur as early as the first week in April in Washington County.

The cutworms can be found on the plants feeding in greatest numbers in the early morning about sunrise and in the evening after sunset. The cutworms hide away in the litter on the soil during the daylight hours, when comparatively few cutworms can be found on the plants, even on severely infested areas.

Besides feeding upon blueberries, the cutworms feed upon most



A nearly full-grown black army cutworm. The large caterpillars feed upon the foliage as well as the blossoms.



The black army cutworm moth. The moths fly at night, and are harmless, except that they lay the eggs to produce the next crop of cutworms.

Small, rapidly growing black army cutworms feeding upon blueberry blossom buds in the early spring. Notice that the small caterpillar chews a tiny round hole into the blossom bud, and eats out the inside.

of the common weed bushes growing on the blueberry land. The cutworms grow rapidly and destroy the leaves as well as the blossoms of the blueberry plants. Severely infested land soon looks as though it had been swept by fire.

The black army cutworms become full grown during late May or early June. The full-grown cutworms stop feeding and go down into the litter on the soil, where they enter the resting stage. During the month of July, the cutworm moths emerge from the soil and fly about the blueberry land at night. The moths lay eggs during August and

probably most of the eggs hatch before freezing weather occurs. The very small caterpillars hibernate over winter and begin feeding in the spring.

Control of the black army cutworm can be obtained by the application of 5 per cent DDT dust, 10 to 15 pounds per acre, as soon as the black army cutworms become active in the spring. It is important to apply the dust while the cutworms are small. If the treatment is delayed, the large cutworms will be more resistant to the DDT and the blueberry crop may be ruined before the cutworms are destroyed.

The detection of cutworm injury in the early stages, before severe injury has been done to the blueberry crop, is very difficult. To see the early injury to the swelling buds requires close inspection of the individual plants. Because of the difficulty of early detection and because a certain amount of insect injury is likely to occur every year, some growers consider it advisable to make an early application of 5 per cent DDT dust to their best land, as insurance, each season, whether or not cutworm injury is found.

Measuring Worms

There are several species of measuring worms, also called inch worms and loopers, that attack blueberries. Perhaps the species most generally destructive to blueberries is the chain-dotted measuring worm (*Cingilia catenaria*).

During September the moths lay eggs on the leaves of sweet fern, blueberry, and other plants. The eggs drop to the ground with the leaves and here the unhatched eggs remain over winter. The eggs hatch in the spring beginning shortly before the blueberry blossoms open. The measuring worms feed upon the leaves of blueberry, sweet fern, and other plants. Where severe infestation occurs, the plants may be stripped of leaves and berries. The measuring worms become full grown in July and August. After passing through a resting stage, the moths emerge to deposit eggs in September.

Control of measuring worms may be obtained by the application of 5 per cent DDT dust shortly before the blueberry blossoms begin to open.

Blueberry Flea Beetle (Haltica sylvia)

Outbreaks of the blueberry flea beetle occur periodically, and more frequently than outbreaks of cutworms. There was a great outbreak of flea beetles on blueberry land in 1936 and 1937. Then there was a period of comparative freedom from flea beetles until 1947, when another outbreak began. The outbreak continued through 1948 and 1949. Like

the cutworms, flea beetles occur as scattered and comparatively mild infestations during the years between outbreaks.

The eggs of the blueberry flea beetle pass the winter mostly in the soil litter near the blueberry plants. The eggs hatch in the spring about the time that the blueberry leaves begin to unfold from the buds. The flea beetle larvae that hatch from the eggs feed upon the blueberry leaves and blossoms until late June, by which time most of the blueberry blossoms have dropped and the berries are setting. The full-grown larvae drop to the ground, where they pass through a resting stage before they transform into the adult beetles. The adult flea beetles appear in numbers and begin feeding upon the blueberry foliage and fruit during July, shortly after the berries begin to ripen. During July and August the eggs are laid to remain over winter and hatch next spring.

Control of flea beetles to protect the plants from severe injury has been possible by using 5 per cent DDT dust applied at about 10 to 15 pounds per acre, soon after the flea beetle larvae began feeding. Where the dust application was delayed too long, the large flea beetle larvae were difficult to kill, the open blueberry blossoms interfered with the application, and where infestation was heavy the plants were severely injured before the treatment was applied. The regular application each year of DDT dust to high-yielding land shortly before the blossoms open, as practiced by some growers, should be worthwhile as "insurance" against severe injury by flea beetles.

Blueberry Leaf Roller (Sparganothis sulfureana)

Leaf rollers most frequently are found on blueberry plants on new burn land during the summer immediately following the burn. Sometimes nearly every plant on considerable areas of land is attacked. The leaves of the infested plants are rolled and webbed together so as to enclose the central stem. The leaf-roller injury shows a striking resemblance to injury by the blueberry thrips but occurs later in the season. Close examination of a plant injured by the leaf roller, however, will reveal a small, greenish caterpillar within the protection of the rolled and webbed leaves. In late summer the leaves become skeletonized from the feeding of the caterpillars. The injury to the leaves might be expected to weaken the blueberry plants. The leaf roller larvae do not usually attack the buds within the shelter of the rolled leaves, however, and generally there appears to be no important reduction of the crop of blueberries on the land following severe leaf-roller infestation.

Control of the blueberry leaf roller on new burn land appears to be satisfactory if 20-20-60 arsenic-copper-lime dust is applied in the "fruit-set" period as recommended for the control of leaf diseases.

DDT applied before bloom has not given protection from leaf-roller infestation. DDT dust or 50-10-40 dust applied at the time of the second fruit fly dust will control leaf roller. DDT is not recommended on bearing land after the blueberry blossoms open, but it can be used safely on new burn land. High-yielding new burn land should be treated as "insurance," or a close watch should be kept for leaf roller attack and the treatment applied at the first sign of infestation.

Blueberry Thrips (Frankliniella vaccinii)

Thrips injury has been observed on Maine blueberry land for many years. During recent years the injury has attracted considerable attention in many localities where it had not been recognized before. Occasional thrips-injured plants can be found on most blueberry land. Severe infestation generally is limited to comparatively small, scattered areas. The thrips may attack the blueberry plants on new burn, first crop, or second crop land. The leaves of the thrips-infested plants do not unfold properly, but remain rolled about the central stems. About



Blueberry Plants Showing Typical Rolling of the Leaves Caused by Thrips.

the end of the blossoming period the thrips-rolled leaves turn a bright red color and become quite conspicuous. On severely infested areas, practically every blueberry plant may be injured. Most of the thrips-injured blueberry stems die and the plants bear few if any berries the following year.

Thrips are exceedingly small insects, almost invisible to the naked eye. They spend the winter in the soil and emerge in the early spring, as soon as the blueberry leaves begin to push out of the buds. The thrips creep down between the separating leaves where they are well protected. The thrips live and multiply within the protection of the rolled leaves until August, when they leave the blueberry plants and go into the soil for hibernation.

Control of blueberry thrips according to recent experiments, is obtained by the application of 5 per cent DDT dust, at the rate of 15 to 20 pounds per acre. The dust should be applied in the early spring, as the blossom buds are separating in the clusters, but before the blossoms begin to open. The application should be made when the air is calm and the plants are wet with dew. Dust applied to dry plants did not give satisfactory results. Very satisfactory results were obtained when the DDT dust was applied to new burn land, just as the plants showed the first signs of growth. Best results were obtained with a concentrated mist blower, using one pound of 50 per cent DDT wettable powder per gallon of water.

Treatments applied later in the season, after the thrips-infested leaves became rolled, have not proved satisfactory.

BLUEBERRY DISEASES AND THEIR CONTROL

M. T. HILBORN

The blueberry is subject to several diseases, some of which cause serious losses to blueberry growers. Some of these diseases occur only occasionally, become serious for several years, and then almost disappear for a period of time. Only those diseases that cause severe losses or are of considerable interest will be considered here. A more complete discussion of blueberry diseases may be found in other publications.⁷

Leaf Rust (Pucciniastrum myrtilli (Schum.) Arth.)

This is one of the most commonly found blueberry diseases in Maine. The disease passes part of its life cycle on hemlock trees, and the other part on the blueberry. A nearly complete infection has been found in August in certain fields of Washington County. The disease produces reddish to brown spots, more noticeable on the under side of the leaf, which may develop yellow pustules. The affected leaves

⁷ Blueberry Diseases in Maine. Maine Agr. Exp. Sta. Bul. 419. 1943. (Now out of print but available in libraries.)

Demaree, J. B., and M. S. Wilcox. Fungi pathogenic to blueberries in the eastern U. S. Phytopath. 37:487-505. 1947.

usually drop from the plant in September whereas healthy leaves remain attached until early winter.



A, Leaf Rust; B, Powdery Mildew Leaf Spot; C, Powdery Mildew, enlarged 4 times. Characteristic appearance from mid-August on.

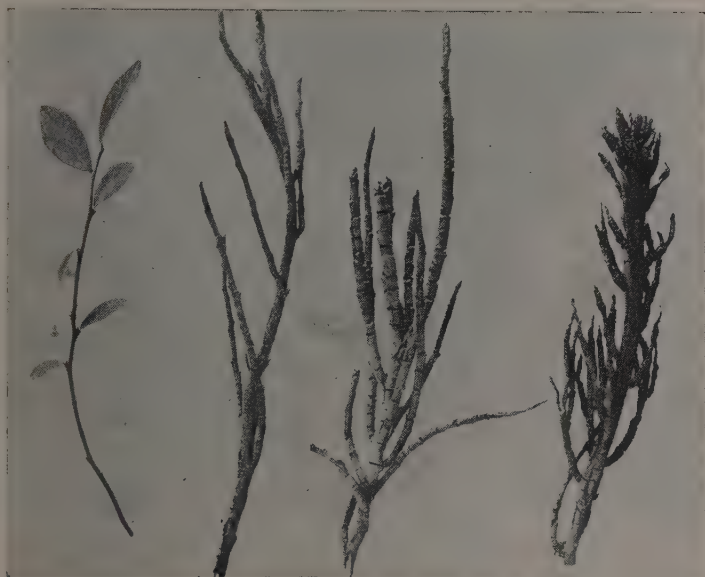
Powdery Mildew (Microsphaera alni DC. ex Wint.)

This is a rather common disease in many blueberry fields, causing a leaf-spotting and early defoliation of affected plants. Various clones of the low-bush blueberry differ greatly in susceptibility to the disease. The disease is most severe on the black-fruited varieties of the low sweet blueberry. Powdery mildew also has been found on high-bush blueberries where there is considerable difference in susceptibility among the many varieties. Usually the affected plants show a thin white cottony growth on the upper surface of the leaves. On some varieties this growth appears only on the lower surface of the leaves and in such instances yellowish spots appear on the upper surface.

Witches'-Broom (Pucciniastrum goeppertianum (Kuhn) Kleb.)

The fungus causing witches'-broom alternates between two host plants. Part of the life cycle is spent on blueberry while the rest is spent on leaves of balsam fir trees. This disease cannot spread from one balsam fir to another but must go from balsam fir to blueberry and then back to balsam fir again. This peculiarity of the disease aids in control, since the disease cannot spread from one blueberry plant to an-

other. In Maine the disease is common on blueberry plants within several hundred yards of woods containing fir trees.



Witches' Broom Has Infected the Three Shoots on the Right, in Contrast to the Healthy Shoot on the Left.

Red Leaf Disease (Exobasidium vaccinii (Fckl.) Wor.)

This is widely distributed in blueberry fields and is conspicuous because the affected leaves turn brilliant red in color. Occasionally entire plants and clones will be affected so that patches of red plants may appear in some fields. The under side of affected leaves shows a thin, white growth somewhat resembling that of powdery mildew.

Mummy Berry (Monilinia vaccinii-corymbosa (Reade) Honey)

This disease is frequently found in some years in blueberry fields, and then in other years is almost completely absent. This variation in occurrence has been attributed to weather conditions in the spring. A cold, wet spring seems to favor the spread of mummy berry. The disease causes a die-back of the shoots, sometimes killing the plants to the ground, and also causes a hard rot of the fruits. This latter symptom is the reason for the name "mummy berry." Affected berries

usually drop from the plants in early fall and do not persist after ripening time.

Brown Leaf Spot

Brown spots, circular to irregular, may appear, and sometimes the edge of the leaf is browned. In some cases this leaf-spotting is caused by arsenical burning, particularly when heavy applications of calcium arsenate dust have been made for fruit fly control. At other times a fungus disease may be the cause. The actual fungus involved has not been clearly demonstrated. In some years brown leaf spot causes quite serious losses in some blueberry fields.

Twig Blight

This is a serious disease of blueberries in some regions of Maine, particularly along the coastal area. It is sometimes mistaken for winter injury which may result from cold, windy weather, especially on northern exposures if the bushes are not covered by snow. More recently, however, several fungi have been found associated with the disease. Affected plants usually begin to die in early fall on new burns and in some cases the entire field is affected the following year causing the yield of berries to be greatly reduced. This particular disease is now being studied intensively both in the greenhouse and in the field to find a satisfactory method of control.

Control of Blueberry Diseases

Pruning blueberry plants by periodic burning is one method of disease control. It often reduces, for a time at least, the amount of various leaf spots. Burning does not control witches'-broom, but this disease may be partly controlled by destroying diseased blueberry plants with various weed killers. The removal of nearby fir trees also will aid in the control of this disease. To aid in the control of powdery mildew, resistant clones and varieties should be selected for propagating and planting purposes.

Research in Maine has shown that the application of fungicides greatly aids in disease control. At present the standard recommendation of a 20-20-60 dust is preferred for disease control. This 20-20-60 dust (calcium arsenate, monohydrated copper sulfate, and hydrated lime) has given a considerable increase in yield when the plants were dusted during the first crop year. The first application should be made when most of the blossoms have dropped, and a second application should be made 10 to 14 days later. If disease is serious, it also may be desirable to make one application during the year of burn and again during the



Twig Blight, Note the Dying Back at the Tip of the Stem.

second crop year. These extra applications should be made 10 to 14 days after blueberry blossoms have dropped. The dust should be applied at the rate of about 50 pounds per acre.

A 10 per cent Fermate dust has shown promise as a fungicide for the general control of those diseases that defoliate blueberries. Preliminary data show Fermate to be at least equal, and in some instances superior, to 20-20-60 dust. It is suggested that growers try Fermate, on a comparatively small scale at first, applying a 10 per cent Fermate dust at the rate of 15 pounds per acre. Two applications should be made, timed the same as for 20-20-60 dust.

Many other new fungicides are being studied by the Experiment Station, and the results will be reported to growers as soon as sufficient information becomes available.

WEED CONTROL

M. F. TREVETT

Effective control of certain weeds of blueberry fields has been made possible by several new chemical weed killers. These materials, how-

ever, have definite limitations. Nearly all of them will kill blueberry plants as well as weeds. This makes it impossible to spray an entire field; instead, individual patches or clumps of weeds must be spot treated by hand.

If weeds are not growing in patches or clumps, safe control can be accomplished only by hand pulling, mowing, or otherwise cutting in midsummer, although with care it is possible to hand spray large individual weeds without seriously wetting blueberry plants.

2,4-D

Compounds of 2,4-D (2,4-dichlorophenoxyacetic acid) will probably find wide use in blueberry fields because they are effective on many of the common weeds, and because certain of the 2,4-D compounds harm blueberry plants less than other chemicals.

Three types of 2,4-D compounds are offered for sale: sodium salts, amines, and esters. The monohydrated sodium salts, and the triethanolamine salts of 2,4-D are the safest to use. In case of accidental wetting of blueberry plants, these forms will be less injurious than the ester formulations. The ester forms, however, are more effective weed killers, and have the added advantage of not easily being washed off by rain. Since the esters give off a toxic vapor, they should not be used near other crops that are extremely sensitive to 2,4-D.

2,4-D will not kill all weeds. Some of the common weeds in blueberry fields are grouped on page 32 on the basis of ease with which they

COMMON WEEDS GROUPED ACCORDING TO SUSCEPTIBILITY
TO TREATMENT WITH 2,4-D PRODUCTS

Weeds that can be killed by 2,4-D	Weeds that may not be killed by 2,4-D	Weeds that cannot be killed by 2,4-D
Alder	Service berry	Bayberry
Dogbane	Sugar plum	Bunchberry
White birch	Chokeberry	Blackberry
Gray birch	Bush honeysuckle	Cinquefoil
Sweet fern	Lambkill	Swamp dewberry
Pin cherry	Mountain holly	Brake fern
Pussy willow	Small tooth poplar	Grasses
Withe-rod	Large tooth poplar	Raspberry
Hawkweed	Rhodora	Red maple
Sumac	Bebb willow	Wild rose
	Mountain ash	Wintergreen
	Meadowsweet	
	Hardhack	
	Poison ivy	

are controlled by 2,4-D. In the first column are the weeds relatively easily killed, in column two are weeds somewhat resistant, and in column three are weeds that evidently cannot be killed by 2,4-D. Weeds listed in the first column usually will not resprout following treatment, weeds in the second group will probably need a second treatment the following year. Complete coverage of the weed with the spray material is essential for a kill. The leaves should be thoroughly wet, but it is not necessary to soak them until the liquid runs to the ground.

Tests have shown that for effective control of weeds the spray should have a 2,4-D concentration of 2000 PPM (parts per million). The amounts of certain commercial 2,4-D products to add to ten gallons of water to make a 2000 parts per million solution are as follows:

Trade Name ¹	Type of 2,4-D	Amount to add to 10 gallons of water
Chipman 2,4-D Sodium Salt 95%	Powder, sodium salt, monohydrate	20 tablespoons ²
2-4 Dow Weed Killer	Powder, sodium salt, monohydrate	20 tablespoons
Dupont 83% Sodium 2,4-D Weed Killer	Powder, sodium salt, monohydrate	20 tablespoons
Weedanol 70% Powder	Powder, sodium salt, monohydrate	20 tablespoons
Chipman 2,4-D Amine, 67%	Liquid, triethanolamine salt	10 tablespoons
2-4 Dow Weed Killer Formula 40	Liquid, alkanolamine salts	10 tablespoons
Dupont 2,4-D 65% Amine Weed Killer	Liquid, triethanolamine salt	10 tablespoons
Weedanol Amine Liquid 40	Liquid, triethanolamine salt	10 tablespoons
Weedar 64	Liquid, amine salt	10 tablespoons
Chipman, 2,4-D Ester 44%	Liquid, isopropyl ester	12 tablespoons
Esteron 44	Liquid, isopropyl ester	12 tablespoons
Weedone Concentrate 48	Liquid, ethyl ester	14 tablespoons

¹ Mention of a trade name product does not constitute an endorsement, nor does the omission of a chemical product imply criticism.

² There are 16 level tablespoons in a level measuring cup.

Ammate

Ammate will kill some weeds that are not killed by 2,4-D but it is extremely harmful to blueberry plants. When used at the rate of one pound per gallon of water ammate has given partial control of red maple. Usually about 50 per cent of the treated red maples will resprout,

and should be retreated the following summer. Leaves, stubs, and stumps should be thoroughly wet.

2,4,5-T (2,4,5-Trichlorophenoxyacetic acid)

2,4,5-T, or mixtures of 2,4,5-T and 2,4-D, in preliminary tests have been effective in the control of brambles, raspberry, blackberry, and wild rose. These products, however, are extremely harmful to blueberry plants and should be used with more caution than 2,4-D products.

Application of Herbicides

The most convenient and least expensive equipment for spot spraying is a three or five gallon cylinder-type pressure sprayer available at most hardware stores.

The nozzle that comes with the sprayer may deliver too coarse a spray. The spray droplets should be relatively small, and the spray fan narrow enough so that it can be accurately directed at weeds without wetting blueberry plants growing nearby. Nozzles designed especially for weed killing can be purchased from most hardware or spray equipment dealers. A suitable nozzle would be one having a 65-degree flat spray pattern, capable of delivering about 40 gallons per acre at a pressure of 30 to 40 pounds per square inch. Nozzles that have been found satisfactory include Monarch No. 59, and Tee Jet No. 6408.

Treatments are most effective if applied to young weeds and sprouts during midsummer (July) of the year of burn. The first leaves of the weeds should be fully formed. If weeds resprout the following year, spray again during July, or when the first leaves have fully expanded.

Precautions in Use of Herbicides

Herbicides will kill blueberries and other crops as well as weeds. Ammate and 2,4,5-T are especially harmful if sprayed on blueberries. Consequently, spot spraying must be done carefully.

Ammate is corrosive to some metals, so equipment should be thoroughly washed with water immediately after use. Lime or baking soda should be added to the last rinse.

The sprayer should be used only for the application of herbicides, and not used for treating insects and diseases.

Do not store 2,4-D or 2,4,5-T near seeds. Their germination may be affected, and plants that grow may be malformed.

Read and follow the manufacturer's directions carefully, as printed on the label on each container.

CROP PROTECTION FROM BIRDS AND ANIMALS

I. C. MASON

Deer

Many blueberry growers report deer damage to certain fields. The deer appear in herds of from 2 to 15 deer at various times of the year. In the early spring, as soon as the blueberry ground is free of snow, deer cause much damage by eating the new fruiting wood and buds. Another time when damage may be severe is just before the blueberry harvest when deer eat large quantities of the ripe berries. The game wardens have cooperated in some instances in the use of blood meal, and other deer repellents, but these procedures have only partially controlled the deer.

An electric fence has been tried at Blueberry Hill Farm and elsewhere to test its effectiveness in controlling deer. When first installed, two strands of wire showed considerable promise for deer control. The deer, however, learned to walk or jump between the wires, even when additional strands were added. Consequently the electric fence has been discarded as an effective method of controlling deer.

Smaller Animals

A number of small animals cause damage to blueberry plants or eat the berries. These may be trapped or caught in the vicinity of the blueberry field. Porcupines usually can be found in spruce or pine trees in the early spring and summer, or their trails can be followed on newly fallen snow in order to locate their tree or den.

Herring Gulls

In earlier years, many blueberry growers along the salt water complained bitterly of the damage to the blueberry crop by the Herring Gulls. The gull was a protected bird, and a grower might be heavily fined if he killed any of the birds. Some growers have strung twine over their fields. Others have tried scarecrows, whirling devices, mirrors, and noise makers, but none of these methods is effective in frightening away the gulls for very long.

In order to control the Herring Gull the U. S. Fish and Wildlife Service, with cooperation since 1947 from the Maine Department of Sea and Shore Fisheries, has been conducting a program of egg destruction.⁸ In the early period from 1934-38 the eggs were punctured with a

⁸ Gross, A. O. The Herring Gull. Mimeographed report of U. S. Fish and Wildlife Service, in cooperation with the Maine Dept. of Sea and Shore Fisheries. June 1949.

needle, but the program was not effective because the eggs became infected and burst or were removed by the gulls, and a second set of eggs was laid. Since 1940 a chemical product has been sprayed on the eggs to prevent their hatching. This method has been successful because it has preserved the eggs so that they do not burst and cause a second set to be laid. During 1942-44 over 70,000 Herring Gull eggs were sprayed annually. During 1949, treatment was given to a total of 19,343 gull eggs on 34 islands along the coast of Maine.

This spraying program is giving effective control of the Herring Gull as shown by recent egg counts on 16 representative islands. The total egg count on these islands was 36,683 in 1945, was 20,116 in 1947, was 14,307 in 1948, and was 10,846 in 1949. These counts indicate a decrease of 70 per cent in the gull population since 1945. A continuation of this program should bring the Herring Gull under reasonable control in most areas within a few years.

In local areas where birds continue to be a menace, the only sure way of protecting the crop is to keep a person in the field from daylight to dark from the time the berries ripen until they are harvested. This is an expensive method, unless this man's time also is used for pulling and cutting weeds, or other useful purpose.

HARVESTING BLUEBERRIES

I. C. MASON

The blueberry crop is harvested during the last of July and through the month of August. The season is slightly later in Washington and Hancock counties than in the rest of the State, usually starting about August 10. The harvesting period usually lasts about one month, but in a hot dry season as in 1949, the crop has to be harvested quickly in a two- to three-week period. Raking should not begin until practically all the berries are well ripened. Otherwise there will be too many green berries and fruit clusters in the boxes.

Most of the low-bush berries are gathered with a hand rake, made of metal, usually containing 42 to 48 teeth. The fields are generally divided by means of strings into lanes about 10 to 12 feet wide to help control the crew and assure complete harvest of all berries. A practical blueberry picking machine has not yet been developed, and would be difficult to use on many fields because of rough ground, stones, or weeds. The few berries that are hand picked are mostly from high bush plants or are for the early fresh fruit market.

Care should be taken in raking to prevent breaking and bruising the berries. Damaged berries not only are an unattractive, inferior



Hand Rakes Are Used for Gathering the Low-Bush Blueberries.
Most hand rakes now contain 42 to 48 teeth.

product, but lose weight, and wet the other berries so that leaves, stems, and other materials gathered up in the rake cannot be winnowed out to obtain a clean product. Raking should not start in the morning until the dew is off the berries because of the difficulty in winnowing wet berries satisfactorily.

Some pickers are hired by the pound or bushel; a few are hired by the hour or day. The latter basis encourages more careful raking, whereas those picking on a bushel basis require more supervision to guard against careless handling. The average rate paid during 1949 by 70 growers was \$1.53 per bushel. The amount of berries picked per day varies greatly according to the ability of the worker, the crop yield, and picking conditions. Most pickers average about 5 to 10 bushels per day.

Most pickers use two one-half bushel baskets into which the raked berries are poured. As soon as the two baskets are filled, the picker carries them to a small power winnowing machine for cleaning. This blows out all leaves and light dirt, while the slow-moving belt carries off green clusters and other foreign materials. It is desirable to keep the winnower and the berries in the shade. The belt should be wiped fre-



A Power Winnowing Machine Is Used for Cleaning the Berries Immediately After Raking.

quently in order to give cleaner berries. The cleaned berries pass from the winnower into one-half bushel boxes which should be cleaned before using. The berries should be delivered to the processing plant at least once every day.

At the processing plant, the berries are further treated to improve their appearance and obtain a cleaner product. Most plants use a washing machine where the berries pass through a water bath to remove dust, dirt, and any possible residue from insecticides. Heavy material such as rocks and dirt are caught at the bottom. Foreign berries such as bunch berries float to the surface and are scooped off along with other light trash. The berries are then carried along on conveyor belts where women pick out any remaining foreign fruit or dirt.



Blueberries Are Transported in One-Half Bushel Boxes for Delivery Each Day to the Processing Plant.

MARKETING THE CROP

M. E. HIGHLANDS

Maine blueberries are marketed in three different forms: fresh fruit, frozen, and canned. The volume of fresh fruit reported in recent years has represented only about one per cent of the total commercial crop. It has been difficult, however, to obtain complete reports on fresh fruit sales, so that the actual volume probably is somewhat larger than



Skilled Workers Pick Out Unsound Fruit, Leaves, or Other Foreign Matter from the Berries at the Processing Plant.

that reported. Nevertheless shipments of fresh fruit are much less than before the war. Competition from other areas has been an important factor in this decline. Fresh fruit usually commands a price premium, especially early in the season. Most berries are sold in quart boxes, cellophane wrapped, 24 boxes to a crate. The principal markets are in New England and New York City.

The frozen product has increased in importance in recent years, accounting for 30 per cent of the total volume handled in 1948, as compared with 21 per cent during 1943-47, and 10 per cent for 1938-42. More detailed information as to the relative amount canned and frozen is given in the following summary.⁹

⁹ Information summarized from annual reports of Blueberry Pack, Div. of Markets, Maine Dept. of Agr.

Item	Average volume per year					
	1924-27	1928-32	1933-37	1938-42	1943-47	1948
Bushels bought	166,098	208,112	196,367	254,016	254,413	422,629
Pounds frozen	—	459,099	769,427	1,052,087	2,214,847	5,261,813
No. cases canned:						
No. 10's	151,438	195,902	167,339	190,080	142,197	136,877
No. 2's	30,044	39,234	50,494	66,675	92,812	139,815
Miscellaneous	—	4,236	24,953	69,421	35,375	251,000
Per cent of volume frozen	—	5	9	10	21	30
Per cent canned as:						
No. 10's	87	86	75	67	60	35
No. 2's	13	13	18	19	31	28
Miscellaneous	—	1	7	14	9	37
Total	100	100	100	100	100	100

The most important outlet for Maine blueberries has been the canned product which accounts for about two-thirds of the crop. The volume of canned berries in earlier years consisted mostly of large No. 10 cans which included 86 per cent of the total volume in 1928-32. The volume canned in these larger containers has not changed much in recent years, but the consumer size cans have become of much greater importance. During 1948, the volume of canned fruit was 35 per cent in No. 10 cans (net contents six pounds, six ounces), 28 per cent in No. 2 cans (net contents one pound, four ounces), and 37 per cent in miscellaneous sizes which mostly contained about one pound per can.

During the war period there was also a small output of dehydrated blueberries, but there is now very little demand for the dried product. A small quantity of blueberries also is used for such byproducts as jelly, jam, and juice, but figures are not available as to the amount produced.

Canned blueberry pie mix also is another product that appears to have commercial possibilities. A formula has been developed by the Experiment Station that has given satisfactory results in preliminary trials. Maine processors may be interested in putting up test market packs of this product.

Work on blueberry juice and blends with apple juice indicates that a straight blueberry juice is preferable.

In marketing the blueberry crop, Maine receives severe competition from other areas. Many low-bush berries are imported from Canada, which compete mostly with Maine's frozen berries. In New Jersey, the production of high-bush cultivated berries has been increasing rapidly and offers strong competition to both fresh and frozen fruit from Maine.

Federal grades have been established for canned and frozen blue-

berries which apply primarily to the high-bush, hand-picked fresh fruit, and are not well adapted to the low-bush product raked in Maine. The principal difficulty in meeting the present U.S. Grade A or U.S. Fancy grades has been the problem of separating clusters and removing stems from the berries. This can be done with the frozen berries, but is more difficult with the fruit which is to be canned. Preliminary work is now underway in an attempt to find, adapt, or develop a mechanical stemmer for fresh blueberries.

The Maine native wild blueberry is famed for its fine sweet flavor and is esteemed for making blueberry pies. Additional improvement in quality will help in developing a market for the expected increase in blueberry production in Maine.

